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thorough and capable navigator, and one who has had extended experience in ice navigation. He should know ice as a mathematician knows figures, and be thoroughly conversant, not only with the working of the ship through fields of ice, but with putting it into and getting it out of the winter quarters. He should have the supervision of the crew—strong, hardy young men, selected from the crews of whaling ships, accustomed to wintering in the Arctic.

Geographical, meteorological, geological, zoological, botanical, and ethnological work in all various departments of their respective branches should each be under the direction of a competent man fitted for such work, and all should be aided in extending their research by the head of the expedition.

Eskimos could be used to good advantage throughout the entire north coast.

An expedition leaving for such an undertaking should be fitted for three to five years' stay.

GEOGRAPHY AND INTERNATIONAL BOUNDARIES.

BY

ISRAEL C. RUSSELL.

The recent bitter controversy between the Argentine Republic and Chile concerning the position of the boundary between their respective territories, the long-continued contention between Great Britain and Venezuela in reference to a similar question, and the still pending discussion as to the meaning of a treaty between Great Britain and Russia, in which the position of a portion of the line of demarcation between Alaska and Canada is involved, furnish instructive lessons in reference to the importance of geographical knowledge on the part of statesmen and diplomats charged with the responsibility of framing international treaties involving the partitioning of land.

The international boundary disputes, just referred to, as is well known, are but recent examples from a long category of similar misfortunes, embracing all historic time, and not infrequently including disastrous wars, as well as heated discussions and lengthy arbitrations. The study of the history of this group of international troubles should show what the germ of the disease is, and how similar disorders may be avoided in the future.

The principles involved in large real estate transfers—for such the acquiring of a title to land by a nation may be justly termed—are fundamentally not different from those controlling the dividing of a farm among the heirs of its former owner, or the sale of a city lot by one man to another. Indeed, the legal contests and the too frequent disputes, with mutual defiance of law, between individuals in reference to property lines, have their counterpart on a larger scale and involving correspondingly greater disasters, in the boundary disputes between nations. The experience gained in the smaller dealings may reasonably be expected to furnish guiding principles for safely transacting the larger business. The most important parts of an ordinary sale of land, in addition to the payment of the stipulated price, are: a search of its title, a survey of its boundaries and the making of them on the ground, together with an accurate description of them in a deed and in many instances on a map, and the official recording of the deed and perhaps also of the map. It is to plain, straightforward real estate transfers of this nature that we hope, if we do not believe, nations are tending, and other and more complex phases of national expansion need not be considered at this time.

In the transfer of the title to land from one individual to another the services of a lawyer and of a surveyor are important, and one is as essential as the other. In the transfer of territory from one nation to another the diplomat—that is, the acute and learned state lawyer—scrutinizes the title of the territory in question from all points of view involving international laws and customs, but the services of the surveyor of broad training and wide experience, or the *geographer*, are much less commonly secured during either the preliminary negotiation leading up to a transfer of territory or the final drafting of a deed to it in the form of a treaty. It is a significant fact, however, that in connection with several of the lengthy disputes and arbitrations concerning treaty boundaries that have arisen, owing to a lack of geographical knowledge on the part of the diplomats who made them, extensive compilations of maps and even detailed surveys of large portions of the earth's surface have been made. Still further arguments might be presented, did space permit, to show that the co-operation of diplomats and geographers is as essential in national transfers of territory as the combined labours of lawyers and surveyors in order to secure a perfect title to land sold by one individual to another.

It is not only important that international boundaries should be described in precise terms, accurately located, easy of identification, and capable of being re-located in case the monuments employed to mark their courses become obscured, but also highly desirable that the best geographical boundaries within the range of choice should be selected before a final interchange of treaties is made. By the best geographical boundary is meant the one which secures the most advantageous adjustment between the activities of men and natural conditions. It is in the adjustment of boundaries to physiographical conditions, as well as in the actual survey and location of them on the ground and on maps, that the geographer may be of service to the state. The history of boundary disputes indicates only too clearly that the negotiations between nations respecting the transfer of territory from one flag to another have in many instances been entrusted to diplomats solely, and geographers not consulted. The dividing lines between nations have not infrequently been described in a few general paragraphs at Ghent, Paris, or Washington by diplomats who, so far as can be judged from the treaties they signed, had but slight knowledge of the geography and resources of the lands through which the boundaries were to run, made no attempt to select the best from the several lines that might have been considered, were not influenced by a desire to adjust the proposed boundary to natural conditions in such a way as to secure the maximum advantages to commerce, etc., of the nations immediately concerned, and gave no heed to the relative merits of the several classes into which boundary lines may be divided.

The first step in an endeavour so to adjust boundary lines to physiographical and political conditions, that the least detriment to the abutting nations shall result, is to classify boundaries and study the merits of the several groups into which they naturally fall.

The boundaries between nations, states, provinces, etc., established in various ways, may be classified, at least provisionally, in six groups. We may term these groups *coast boundaries*, *astronomical boundaries*, *water boundaries*, *mountain boundaries*, *divide boundaries*, and *arbitrary boundaries.*

Coast Boundaries.—The junction of the sea and land on the borders of continents and islands furnishes natural and clearly-defined lines, which are evidently the most desirable of any of the various classes of boundaries for defining political limits. By international consent the jurisdiction of a country bordering on the "high seas" is a line one marine league seaward from the margin of the land, and following its meanders. As an international dividing line the one league limit seldom, if ever, becomes important, since the nice adjustment of the width of an arm of the sea necessary for such a purpose rarely occurs. When an extension of the ocean's waters, intervening between two nations, is less than two marine leagues wide the boundary between them commonly follows its medial line, and has all the essential features of a water boundary, described below.

Astronomical Boundaries.—The shape of the earth and its motions in reference to the sun are such that certain imaginary lines on its surface may be located with precision by astronomers, and if the monuments or other marks employed to show the positions of such lines are removed they can be accurately re-located. The lines referred to are principally parallels of latitude and meridians of longitude, and boundaries, so far as they coincide with these lines, may for convenience be classed as astronomical boundaries.

Examples of the class of boundaries here indicated are furnished by the one defining the east border of the main body of Alaska, which, as defined in a treaty made in 1825 between Great Britain and Russia, is the 141st meridian west of Greenwich; and by the boundary between Canada and the continental portion of the United States from near the Lake of the Woods westward to the coast of the continent, which, as finally decided in a treaty between Great Britain and the United States in 1846, is the 49th parallel of north latitude. The boundaries of a number of the States of the United States, and of several of the Provinces of Canada, are either wholly or in part parallels of latitude or meridians of longitude, and furnish good examples of what are here termed astronomical boundaries.

The most conspicuous advantages of astronomical boundaries are that they may be accurately described without a knowledge of the country through which they pass. They can be located with precision and their courses accurately marked by monuments. For these reasons astronomical boundaries, when clearly defined in treaties between nations or in laws concerning the territorial limits of states or provinces, leave no room for contention as to their positions.

The leading objections to the use of astronomical boundaries, particularly as international dividing lines, are: The temptation they offer to diplomats and others, who may be interested in the speedy conclusion of a treaty, to make hasty divisions of territory without knowing its resources or commercial and other possibilities. Then, too, such boundaries cross the land without reference to its topography, and have no essential relations to the courses of streams or the directions of coast lines, etc. They may divide a fruitful valley in a most arbitrary and inconvenient manner between two nations with widely-different laws and customs, or cross a navigable river at several localities, and intersect a coast or lake shore so as to initiate complex conditions in respect to harbors, navigation, customs duties, etc. In these and still other ways boundaries coinciding with lines of latitude and longitude are apt to bring about detrimental commercial and other relations between adjacent nations, states, and provinces. A region which is an industrial unit—as the gold fields of the Klondike district, the iron-bearing tracts to the west of Lake Superior, the wheat lands of the Red River valley, the forested lands of the North West coast, etc.—when divided between two or more countries with different laws, is deprived of the advantages that should follow from the natural course of industrial development, and one part or the other suffers in consequence.

Again, until an astronomical boundary is surveyed and marked on the ground by skilled geodesists, it cannot be located even approximately by miners, trappers, foresters, and others, and many difficulties are apt to arise in this connection.

Although an astronomical boundary once decided on and formally recorded in a treaty leaves no excuse for national quarrels as to its position, it is evident that its far-reaching and perhaps highly-complex influences on the development of neighbouring peoples are likely to be such that the natural resources, conditions affecting transportation, etc., of the region through which it passes should be thoroughly understood before a final decision is reached.

Water Boundaries.—In numerous instances the medial line or one shore of a stream, lake, estuary, strait, or other water body not recognized as a part of the "high seas" has been selected to serve as a fence between nations and states; collectively, such dividing lines, typically represented by a river without islands, flowing between well-defined and permanent banks, may conveniently be termed water boundaries. In general, when a stream, lake, etc., is a national or state boundary, its medial line, or the centre of the main channel when there is more than one, is defined as the precise line of demarcation.

The leading features of water boundaries are illustrated by a portion of the line separating the United States from Canada, which traverses the middle of the St. Lawrence River, and divides medially several of the Great Lakes and their connecting streams. The south boundary of the United States is also in part a water boundary, and is defined by treaty as "the middle line of the Rio Grande, or its deepest channel where there is more than one."

In certain instances, when a river, lake, bay, etc., separates two political organizations, one shore or the other may be defined by treaty or by law as the actual line of separation, and even complex relations may exist, in reference to jurisdiction over the dividing waters. The water boundary between New York and New Jersey, for example, is, in part, the middle line of the Hudson and of New York Bay, etc., with several qualifications, including exclusive jurisdiction by New York over the waters of the Hudson to the west of Manhattan Island to the low water line on the New Jersey shore, subject, however, to certain rights of property and of jurisdiction of the State of New Jersey, etc. The waters of Delaware River are by agreement between New Jersey and Pennsylvania a common highway, over which each State "shall enjoy and exercise a concurrent jurisdiction within and upon the water, and not upon the dry land between the shores of said river"*; the islands in the river being specifically assigned to the one or the other State.

The advantages of a water boundary are suggested by the fact that in most instances they may be easily located, even by persons inexperienced in the method of surveying. Coinciding, as they generally do, with definite geographical divisions, they do not lead in a conspicuous manner to complications in the industrial development of the countries or states separated by them.

The difficulties to which water boundaries may give rise are indicated by the fact that streams, more particularly than the other water bodies in question, frequently divide so as to enclose islands, and in certain instances on nearing the sea send off, perhaps, several distributaries, which discharge through independent mouths. When a stream divides so as to enclose an island, even if the main or the deeper channel is specified by treaty or by law, as the one chosen as a boundary, the question as to which of two channels is really the larger or the deeper may not permit of definite answer. Streams are subject to many changes, and what is the main channel one year may become of secondary rank the next year, or a river, as not infrequently happens, may shift its course bodily, and thus furnish grounds for contention as to the ownership of the territory transferred from one of its banks to the other. The distributaries of streams, or the separate channels into which they divide on deltas, etc., are also subject to conspicuous and sometimes sudden changes. Who could decide, for instance, which is the main channel of such rivers as the Mississippi, the Nile, or the Ganges, in the delta portions of their courses; or if a choice seemed practicable, is there any assurance that the distributary, largest to-day, will maintain its supremacy for a decade to come, or even be in existence a century hence?

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* Henry Gannett. *Boundaries of the United States and of the several States and Territories.* U. S. Geological Survey, Bulletin No. 171, second edition, Washington, 1900.

The controversies that may arise in reference to which of two channels in a designated water-body is the main one, are illustrated by the well-known "San Juan episode," which came near bringing on hostilities between Great Britain and the United States in reference to the ownership of certain islands in the Strait of Georgia; the immediate subject of contention being whether "the channel which separates the continent from Vancouver's Island," as the statement reads in the Webster-Ashburton treaty, 1846, passes to the east or to the west of the San Juan Islands. The Emperor of Germany, as is well known, acting as arbitrator, decided that the islands belong to the United States. Thus, in 1872, a series of disputes as to the Canadian-United States boundary, which had been carried on for ninety years, was closed.

While water boundaries and especially rivers, in certain instances, have furnished almost ideal dividing lines between nations, in other instances they have proved to be objectionable. The difference lies in the nature of the streams themselves, and illustrates the fact that, with water boundaries as with other classes of dividing lines between nations, a critical knowledge of the geography of the region through which they pass is a pre-requisite of treaty-making, if subsequent boundary disputes are to be avoided.

Mountain Boundaries.—The crests of mountain ranges, or mountain chains, are sometimes specified in treaties as defining territorial limits. The ideal mountain range is one having a generally straight alignment and a continuous and sharply-defined crest, but in nature this ideal is seldom attained. Modern geographical studies have shown that many so-called mountains, which from a distance appear to be well-defined uplifts with sharp crest-lines, are in reality broad plateaus or great domes, deeply dissected by stream erosion. In such instances it is frequently difficult to decide where the crest of the range is located. Indeed, as is not infrequently the case, there is no definite and tangible crest-line. Although it is sometimes assumed that the crest-line coincides with the water parting, or the divide, between the head-branches of streams flowing in opposite directions from a mountain-like uplift, it is well known that a mountain range, even when bold and sharply defined, may not be a divide for the principal streams of the region where it is situated. An illustration in point is furnished by the Appalachian Mountains, through which the Susquehanna, Delaware, and other important rivers rising in the plateau to the west flow transversely in deep valleys and empty into the Atlantic.

The recent controversy between Argentina and Chile was due to an assumption in a treaty between them that the crest-line of the Southern Andes coincides with the water-parting between the streams flowing to the Atlantic and those discharging into the Pacific. Post-treaty surveys, as they may suggestively be termed, have shown that in the portion of the Andes in question streams rising well to the east of the mountains flow westward through them in deep transverse cañons, and that there is a wide discrepancy between the continental water-parting and the topographic crest-line of the continent.

A mountain boundary, if defined as the line along which the upward slopes on the opposite sides of a prominent uplift meet in its summit portion, would in most instances be irregular and perhaps conspicuously intricate, for the reason that mountain crests are modified and shaped by erosion and migrate in one direction or another according to the strength and other qualifying conditions of the opposite-flowing streams. Then, too, an uplift which seems to a casual observer to be a single mountain range may, in reality, be highly complex, and no continuous crest-line be discoverable. In short, the sweeping statements sometimes embodied in treaties, to the effect that the line of demarcation between contiguous countries shall be the crest-line of a certain indicated mountain range are fraught with uncertainties and difficulties, which are likely to prove a source of discontent and costly arbitration, or even lead to war.

Divide Boundaries.—A boundary which is defined as following a specified water-parting or divide, from which streams flow in opposite directions, would in most instances be easily traceable on the ground even by persons unskilled in the art of surveying, and for this and other reasons has much to commend it; yet, without an accurate knowledge and, most of all, an accurate topographic map of the region through which such a boundary is to pass, its selection on general principles, however nicely worded, is open to dangers of the same nature as those pertaining to a similar choice of a mountain boundary.

In arid regions broad plateaus may form divides, and even an approximate location of the line of water-parting, if one exists, be a matter of difficulty and uncertainty. Then, too, the process of head-water corrasion pertaining to essentially all streams, and of stream capture, or the acquiring by one stream, through the process of stream development, of the territory formerly drained by its neighbour, leads to a migration and sometimes a sudden and perhaps extensive shifting of a water-parting.

Examples of divide boundaries are furnished by the one separating Idaho and Montana, which in part coincides with the continental divide, and serves its purpose well; but the satisfaction it has given is to be qualified by the fact that, for the most part, it is situated in a rugged region, where there is but slight probability of the property interests of the communities parted by it coming into direct contact.

Boundaries which are made to coincide with the courses of rivers, with the crest lines of mountains, or with water-partings, have certain commendable features in common; they are easily located, readily defined by natural features of the earth's surface, and in general do not require to be accurately surveyed and marked by monuments before they serve their purpose as international or inter-state fences.

Arbitrary Boundaries.—A class of boundaries not otherwise readily definable may be conveniently designated as arbitrary boundaries, since, as a rule, they are not described in terms such as pertain to astronomical boundaries, and bear no necessary relation to topographic or other features of the regions they traverse. Like astronomical boundaries, the ones here considered are imaginary lines, and, in part, might with propriety be included in that class, since they are capable of being located by astronomical methods; but they serve our purpose better if considered in a group by themselves. The class of boundaries here referred to includes straight lines connecting two points; lines defined as running in a given direction (azimuth) and for certain distances; arcs of circles; tangents to circles, etc. In brief, arbitrary boundaries may be defined as straight or curved lines or combinations of such lines, and are similar to the lines employed by surveyors in marking the boundaries of a farm, locating a railroad, etc.

An example of what is meant by an arbitrary boundary is furnished by the line separating Delaware from Pennsylvania, which is an arc of a circle twelve miles in radius, with the steeple of the old court-house in Newcastle, Delaware, as a centre. Again, in the establishment of the District of Columbia, a rectangle ten miles square was chosen and marked on the ground by means of monuments as the site of the capital of the United States. Another illustration is furnished by the eastern boundary of California, as defined in its constitution. This boundary runs from the intersection of 120 degrees of west longitude with the 39th degree of north latitude, in a straight line in a southeasterly direction to the River Colorado, at a point where it intersects the 35th degree of north latitude.

Boundaries of the nature just cited can only be recognized when actually marked on the ground, and except in the case of straight lines, not of great length, or small geometrical figures, are difficult of precise location, even by skilled surveyors. Should the monuments used to define their positions be destroyed, their replacement is an arduous task.

Impracticable Boundaries.—There are certain dividing lines which are defined in treaties, decrees, etc., as running parallel to some natural feature, as a coast or a river, and at a given distance from it, that might with propriety be classed as arbitrary boundaries, since no effort is made to adjust them to the natural conditions of the immediate territory they traverse; but, for the purpose of expressing a still greater weakness inherent in them, they are here specially designated as *impracticable boundaries.* This, as is to be hoped, temporary class of boundaries includes the proposed lines of demarcation sometimes inserted in treaties, etc., which it is impossible, or at least impracticable, without great and, for the most part, useless expense of time and money, to mark on the ground, and thus seek to make serviceable.

In this connection reference may be made to the boundary between southeastern Alaska and Canada, which, as stated in the treaty between Great Britain and Russia previously referred to, in the absence of a mountain range parallel with the coast and not over ten marine leagues inland—and as subsequent explorations and surveys have shown such is the case—"shall be formed by a line parallel to the windings of the coast, and which shall never exceed the distance of ten marine leagues therefrom." The region through which the line described would pass, if surveyed, was almost entirely unknown at the time the treaty referred to was made, but, as has since been discovered, it is exceedingly rugged, and contains many mountains, ranging from 10,000 to 18,000 feet high, besides a multitude of glaciers and many extensive fields of perpetual snow. To survey and mark on the ground the boundary indicated in the treaty would be what may be justly termed an impossible task; and, besides, if the line as defined by treaty should be established, it would be intricate, and much less serviceable as a national fence than any one of several possible boundaries that could have been chosen, with essentially the same end in view, at the time the original treaty was entered into, had a geographer been employed to make even a hasty reconnoissance of the region in question.

Another example of a boundary being defined as running parallel to and at a specified distance from an irregular geographical feature, is furnished by a part of the boundary between Massachusetts and New Hampshire, which is a line parallel to Merrimac River, and distant from it three miles on the north. In this case, although the distance of the line designated from the one to which it is to be drawn parallel is but three miles, and the country between only mildly undulating or hilly, the boundary as now marked on the ground and accepted as an interstate boundary, is but a rude approximation to the one originally defined.

These examples, and others that might with propriety be classified as impracticable boundaries, illustrate again the desirability of accurate geographical knowledge, and still more of an adequate appreciation of the difficulties and limitations met with by the surveyor, on the part of those who attend to the real estate business of nations.

The reader will perhaps ask, now that we have something of the relative merits of the various classes of boundary lines before us, which class is best and what kind of a boundary should be chosen in case new treaties involving a transfer of territory from one nation to another become necessary. The reply is, that such a choice must be determined by the conditions met with in individual cases, the prime requisite being an accurate knowledge of the geography, natural resources, and commercial advantages of the territory to be divided. These data should be in the hands of the agents of the nations participating in the transaction, and, to a great extent, can best be presented on topographic maps.

While it is not to be expected that the entire earth can be subdivided among nations on strictly geographical principles, making each international boundary coincide with a strongly pronounced topographic feature, and assigning to each political division a definite geographical unit, as, for example, an entire continent, or island, or a definite river system, or drainage slope; yet, in many instances, as the history of boundaries shows, there have been opportunities to make at least some adjustment of political to natural divisions, and other opportunities in the same direction will, no doubt, recur in the future. In locating a railroad or other similar task preliminary surveys of several possible lines are usually made, and their relative advantages compared, before a final route is chosen; logically, it is still more important that an international boundary should represent the net result of several trial surveys, in order that the best possible line under the prescribed political and social limitations in each case may be discovered. If circumstances dictate that an international boundary is to be agreed upon, which intersects a new country, of which no reliable maps are available and trial surveys are debarred, it is plainly apparent, from the relative merits of the various classes of boundary lines, that either an astronomical or an arbitrary boundary, or a combination of the two, should be chosen, if all danger of future broils is to be avoided. Under the conditions referred to, it is apparent that a purely astronomical boundary will best serve the desired purpose. With an accurate topographical map of a region which is to be divided, in hand, trial surveys can be made on it as well in many ways, as if they were actually traced on the ground; but, in addition, the geological and other resources of the region need to be known. With all of this essential information available, the final choice of a definite boundary would be regulated by a large number of local conditions, and a composite boundary, adjusted throughout to natural conditions, would probably be found to serve the desired end most efficiently.

The services of geographers in connection with boundary treaties, pertaining particularly to new regions of the earth, should not be considered simply as a means of perfecting titles and of removing grounds for future disputes, highly desirable as such aims manifestly are, but in order that the best possible adjustment of natural resources, avenues of interior communication, and accessibility to the ocean highways of commerce may be secured to each of the parts into which a given territory is divided. A just and reasonable adjustment of boundaries involves something more than the consideration of square miles of territory, since the intellectual and commercial development, not only of the adjacent nations but of all mankind for perhaps many centuries, is involved therein. It may perhaps be urged in opposition to this imperfectly stated, but, as is intended, broad and fraternal view of international relations, that the greed of nations for territory renders the services of the geographer unnecessary to the framers of treaties, except so far as they remove grounds for dispute—and perhaps not even then, since an aggressive nation may design to involve its neighbours in fresh controversies. Admitting that greed is the controlling principle in international transactions, and will no doubt continue to be so until the earth has been rendered uninhabitable by reason thereof, it is still just to claim that the more fully the participants in a struggle for territory are mutually informed in reference to its present and future values, the more nearly will a reasonable adjustment of its boundaries to natural conditions be secured.

HYDROLOGIC AND HYDROGRAPHIC SURVEYS OF THE UNITED STATES.

As a result of the creation of the new reclamation service under the United States Geological Survey to construct canals, reservoirs, and affiliated works for the irrigation of the public lands of the arid regions of the West, the hydrographic branch of that bureau has been reorganized. As constituted it consists of three principal divisions—namely, hydrography, hydrology, and reclamation surveys, all under the chief engineer, Mr. Frederick Haynes Newell. In bringing about this reorganization the words *hydrography* and *hydrology* have received a special and more limited meaning. Like geography and geology (the latter of which is a special outgrowth of the former, and has to do with the underground geography of the earth's surface), so the name hydrology has been adopted as implying a study of the underground water resources, as distinguished from hydrography, which term is limited to apply to the surface water supplies and sources.

The hydrographic division of the Geological Survey is devoting